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## SPECIFICATION

5 METHOD AND APPARATUS FOR  
COMMUNICATION OF MISSING LOGIC IN A PCI BASED SYSTEM BY  
ENABLING OR DISABLING PCI CONFIG CYCLES

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BACKGROUND OF THE INVENTION

### Field of the Invention

The present invention relates to data communications. In particular, the present  
invention relates to routers and the detection and communication of missing Phy Level  
15 logic to a host processor.

The Prior ArtBackground

The Personal Computer Interface (PCI) bus standard has found widespread use in today's data communications system, primarily because of the advantages found in the PCI standard. For example, one advantage of the PCI design is that up to 256 devices can be attached to one PCI local bus, and up to 256 PCI busses can exist in one system. Furthermore, PCI is a Plug and Play architecture - it is auto-configured by system BIOS. This means that system resource assignments destined for expansion devices (such as IRQ assignments and address space) is all automated, there is a greatly reduced chance of resource allocation conflicts. These features of the PCI bus make it one of the most suitable architectures available to the PC industry today.

As is known by those skilled in the art, the basic components of the PCI bus include: the PCI BIOS, a CPU, a CPU Cache, System Cache, System Memory, a PCI Bridge, and a Peripheral bus. Each component performs a specific task associated with accomplishing communication via the PCI bus. Thus, each component has a specific method that it uses to interact with adjacent components. Because these methods of component interaction are the same in all PCI systems, the PCI design is inherently adaptable to a variety of configurations. It is standard to include embedded devices and peripheral devices on the same bus for this reason.

One application where a PCI system must adapt for a variety of configurations is within a router. Figure 1 shows a prior art diagram of a router having a PCI-compliant bus deployed therein.

FIG. 1 includes a router motherboard 100, known as a front card. Front card 100 has hardware and software standard in the art. FIG. 1 also includes a daughterboard 101, known as a back card. Back card 101 represents a Fast Ethernet-compliant (FE) device coupled to front card 100. Back card 101 includes a FE Media Access Controller (MAC) 110 configured to perform OSI-standard Layer 2 functions. Back card 101 also includes a FE Physical (Phy) controller 112 configured to perform OSI-standard Layer 1 functions. FE Phy 112 is coupled to FE MAC 110 via a MII (Media Independent Interface) interface 114 standard in the art.

Back card 101 also includes an identification programmable read-only memory (ID PROM) 104 configured to provide information about the back card 101 to the front card 100 via a serial bus 102 standard in the art.

As can be seen by inspection of FIG. 1, in order to couple the back card 101 to the front card 100, the FE MAC 110 must be coupled to the front card 100 via the 32-bit wide PCI address data bus (PCI\_AD) 108. Additionally, the PCI identification select connection (PCI\_Idsel) 106, with resistor 106 serially disposed therein, and the serial bus

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102 must also be coupled. Thus, a suitable physical connector capable of making this  
plethora of connections must be provided.

As will be appreciated by those skilled in the art, such a connector is rather large  
when compared to the size of the components being connected, especially given the ever-  
5 decreasing size of semiconductor devices. Because circuit board real estate is so  
valuable, the prior art searched for ways to eliminate the area penalty imposed by a  
connector which must make so many connections.

Figure 2 shows one solution proposed by the prior art. Similar designations are  
intended to designate substantially similar matter herein throughout. As can be seen by  
10 inspection of FIG. 2, the solution proposed was to locate the FE MAC 110 on the front  
card 100, thus eliminating the need to physically couple the PCI\_AD bus 108 through a  
physical connector and re-gaining the area savings by eliminating the need for a large  
connector.

However, the prior art solution of FIG. 2 posed certain problems.

15 By way of background, when a PCI-compliant device is coupled to a host device,  
certain procedures occur to ensure a proper connection. An important aspect of the PCI  
standard is the identification of devices which have made themselves available to the bus.  
When a device is present, it makes its presence known by responding to the host when its

IDSEL input is driven high during a config cycle. During the config cycle, a device is targeted by a combination of Command/byte enable signals ( $C/BE[3:1] = 101$ ) during the PCI address phase, and by making active the devices' IDSEL input. All devices on the PCI bus will look at their IDSEL inputs and will respond if the IDSEL input is active.

- 5 Typically the IDSEL pins are driven by one of the Address bus bits  $AD[31:11]$  which is typically resistively coupled using a 50K Ohm resistor 105. Each device gets its own Address bit.

For example:

PCI\_AD[11] -> FE MAC #1 IDSEL input

10 PCI\_AD[12] -> FE MAC #2 IDSEL input

- As can be seen by inspection of FIG. 1, this procedure worked fine (i.e. host software could easily identify a missing Fast Ethernet interface) when the FE MAC 110 was located on the back card 101. However, when the FE MAC 110 was moved to the front card 100, the FE MAC 110 was now permanently coupled to the front card 100 through the connection of the PCI AD signal to the FE MAC's IDSEL 106. Thus, the FE MAC IDSEL connection will always be driven when the host checks for devices, creating the risk that the FE MAC may mistakenly believe that a device is connected when in fact there is no FE Phy present.
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To compensate, the prior art developed software to detect whether an FE Phy was present. One example of such software utilized the ID PROM to determine whether a FE Phy was present. In this example, the ID PROM was programmed to communicate whether there was a FE Phy installed on a given channel.

5           However, such solutions have certain disadvantages. If the ID PROM is not programmed correctly or malfunctions, the front card 100 may mistakenly sense that a back card device is connected when in fact no FE Phy is present. In this case, the PCI scan of the FE MAC device would identify the interface as being present.

10           Furthermore, such software adds processing overhead and may be prone to errors, thereby decreasing the overall efficiency of the host device.

Hence there is a need for a method and apparatus to identify when a FE Phy is present in a PCI-compliant system which does not suffer from the disadvantages of the prior art.

#### BRIEF DESCRIPTION OF THE INVENTION

15           The invention satisfies the above needs. The present invention relates to data communications. In particular, the present invention relates to routers, and or switches and the detection and communication of a PHY Level logic to a host processor.

A method and apparatus for the detection and communication of a missing component of a Fast Ethernet interface to a host device is disclosed. The present invention solves the problems of the prior art without the need for additional software or programming.

5 A first aspect of the present invention includes a front card configured to accept a Fast Ethernet device on a PCI-compliant bus, and the front card includes a switch which is serially disposed on a PCI\_AD to device IDSEL connection corresponding to a particular channel on said front card. The switch is further configured to receive a sensing signal corresponding to said channel from said device. The apparatus is  
10 configured to enable the connection of PCI\_AD to FE MAC device IDSEL on the front card if the sensing signal is in a first state, and provide a low potential to the device's IDSEL input on the front card if said sensing signal is in a second state.

A second aspect of the present invention comprises switching means disposed on the front card; said switching means being configured to receive a sensing signal from the  
15 back card. The sensing signal has a first and second state, and the switching means is configured to provide a predetermined signal to the front card depending on the state of the sensing signal.

A third aspect of the present invention is a method comprising receiving, by the front card, a sensing signal from the back card; if the sensing signal is a logical low, then

providing a PCI\_AD to device IDSEL connection corresponding to a particular channel of said back card to the front card; and if the sensing signal is not low, then decoupling the PCI\_AD to device IDSEL connection and providing a logical low signal in the place of the PCI\_AD line.

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#### BRIEF DESCRIPTION OF THE DRAWING FIGURES

Figure 1 is a prior art diagram of a PCI-complaint communications system.

Figure 2 is a further prior art diagram of a PCI-complaint communications system.

Figure 3 is a schematic diagram of an apparatus according to the present invention.

Figure 4 is a schematic diagram of an apparatus according to the present invention.

Figure 5 is a flowchart of a method according to the present invention.

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DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Persons of ordinary skill in the art will realize that the following description of the present invention is illustrative only and not in any way limiting. Other embodiments of the invention will readily suggest themselves to such skilled persons having the benefit of this disclosure.

The present invention may be described through the use of flowcharts. Often, a single instance of an embodiment of the present invention will be shown. As is appreciated by those of ordinary skill in the art, however, the protocols, processes, and procedures described herein may be repeated continuously or as often as necessary to satisfy the needs described herein. Accordingly, the representation of the present invention through the use of flowcharts should not be used to limit the scope of the present invention.

The present invention provides a method and apparatus for the detection and communication of a missing LAN or WAN compliant device, such as a Fast Ethernet device to a host device. The present invention overcomes the problems of the prior art by providing circuitry which disables the connection of PCI\_AD to device IDSEL pin when a FE Phy device is not present.

Two aspects of the present invention will now be disclosed, a first aspect includes the situation when a FE Phy is present on a particular backcard, and the second aspect includes the situation when a FE Phy is not present on a particular backcard. A method according to the present invention is also presented.

5        Figure 3 is schematic of a first aspect of a detection device according to the present invention. Similar designations are intended to indicate substantially similar matter herein.

FIG. 3 includes a router front card 100 having hardware and software standard in the art as disclosed in FIGS 1 and 2. FIG. 3 also includes a back card 101 which  
10        represents a Fast Ethernet-compliant physical layer device (FE) device to coupled to front card 100. Front card 100 includes a FE MAC 110 configured to perform OSI-standard Layer 2 functions. Back card 101 includes a FE Phy controller 112 configured to perform OSI-standard Layer 1 (phy layer) functions. FE Phy 112 may be coupled to FE MAC 110 via a MII interface 114 standard in the art. Backcard 101 may also include an

15        ID PROM (not shown) as in FIGS. 1 and 2.

Back card 101 also includes an identification programmable read-only memory (ID PROM) 104 configured to provide information about the back card 101 to the front card 100 via a serial bus 102 standard in the art.

FIG. 3 includes a switch 116 serially coupled with IDSEL 106. Switch 116 has an input 128, an output 130, and a switching input 126. It is contemplated that switch 116 may be fabricated from any electrical circuit standard in the art, such as transistor or logic circuitry. In an exemplary non-limiting embodiment, switch 116 comprises a tri-stateable  
5 buffer standard in the art.

FIG. 3 also includes a pull-down (PD) device 120. PD device 120 is coupled to the output 130 of switch 116. PD device 120 may comprise electrical means standard in the art for placing the IDSEL connection 106 at a ground potential. In an exemplary non-limiting embodiment, PD device 120 comprises a resistor having a value of  
10 approximately roughly 5K Ohms.

FIG. 3 also includes a switching line 118 coupled to the switching input 126 of switch 116. FIG. 3 further includes pull-up (PU) device 122. PU device 122 may comprise electrical means standard in the art for placing the switching line 118 at a high potential. In an exemplary non-limiting embodiment, PU device 122 comprises a resistor  
15 having a value of approximately roughly 5K Ohms.

Switching line 118 is also configured to be coupled to back card 101 through a connector standard in the art. On back card 101, switching line 118 is terminated at a sensing point 124.

In an exemplary non-limiting embodiment, sensing point 124 is configured to electrically float if there is no FE Phy present, and to be coupled to a low potential or ground if there is a FE Phy present.

It is contemplated that the coupling is done at the factory during assembly through the loading of a 0 Ohm resistor. If the FE Phy is not loaded on a particular backcard, then the associated 0 Ohm resistor is also not loaded. It is also contemplated that this 0 ohm resistor may comprise a jumper which can be installed or removed just before shipping the product. Utilizing a jumper has the advantage whereby a manufacturing operation utilizing the present invention can produce only a single assembly and customize it later by activating the proper number of ports purchased by a customer.

The operation of the circuitry disclosed in FIG. 3 will now be described. FIG. 3 illustrates the case where the FE Phy 112 is present. Thus, it is desired that this be communicated to the FE MAC.

When a FE Phy is present, sensing point 124 will be brought to a low or ground potential. When sensing point 124 is brought low, switch 116 will be opened by virtue of the low being applied to inverting switch input 126. Thus, from the perspective of the front card 100, sensing point 124 on the back card 101 provides a sensing signal to the front card 100 which indicates whether there is a FE Phy present on the corresponding channel of the back card. It is contemplated that the sensing signal being low may

represent a first state, and when the sensing signal is not low, the sensing signal is in a second state.

It should be noted that PU device 122 and PD device 120 are configured to operated as "weak" buffers, and switch 116 is configured to operate as a "strong" buffer.

5 As is known by those of ordinary skill in the art, the operational state of switch 116 will then control the operation of the present invention. Thus, when sensing point 124 is brought low, switch 116 will be opened in spite of the presence of PU device 122.

10 Therefore, when a FE Phy is present, the switch 116 is opened, the IDSEL connection 106 is coupled to the FE MAC 110, and the back card will be coupled to the front card via the bus per normal PCI procedures.

Referring now to FIG. 4, a schematic of a second aspect of a detection device according to the present invention is shown. FIG. 4 illustrates an example where the FE Phy is not present. FIG. 4 includes structure substantially similar to FIG. 3.

15 When the FE Phy 112 is not present, sensing point 124 is configured to electrically float. As is appreciated by those of ordinary skill in the art, sensing point 124 may also have a high potential, but floating the signal is beneficial since backcard power is not required to identify the missing component. When sensing point 124 is floating, the PU device 122 will control, and thus apply a high potential to switching input 126 of switch

116, thus closing the switch 116. When the switch 116 is closed, the IDSEL connection 106 is decoupled from the FE MAC 110.

When switch 116 is closed, the PD device 120 will control, and apply a low potential to FE MAC 110. As will be appreciated by those of ordinary skill in the art, when the FE MAC 110 senses a low on the IDSEL connection 106, it will determine that there is no FE Phy present on that particular channel. Thus, FE MAC 110 will not expect there to be a FE Phy present on MII interface line 114. Thus, the result of the operation shown in FIG. 4 is that the IDSEL connection for a particular channel will be decoupled, and a low potential provided to the FE MAC in its place.

Thus, the structure disclosed in FIGS. 3 and 4 provides an excellent example of a means for detecting and communicating the absence of the Physical layer device in a communication system to a host device.

Figure 5 is a flowchart of a method for detecting and communication of a missing FE device to a host device. The process of FIG. 5 begins in act 500 with the host device receiving a sensing signal from a back card which is coupled to a PCI-compliant bus.

In query 502, the path of the process depends on whether the sensing signal is a logical high or low. If the sensing signal is high, the IDSEL connection will be coupled to the FE MAC of the host device in act 504. If the signal is low, then the corresponding

IDSEL connection will be decoupled from the FE MAC, and its place, a logical low or ground potential will be coupled to the corresponding IDSEL connection of the FE MAC in act 506 . The process of FIG. 5 then ends.

While the descriptions above have focused on the application of an FE Phy and FE MAC there are other individual devices for Layer 1 and Layer 2/3 functions that will benefit from the present invention. Other examples are shown in Table 1:

**TABLE 1**

L2/3	via	L1
FE MAC	MII	Fe Phy
HDLC control	TDM bus	T1/E1 framer / Line interface
ATM SAR	Utopia	ATM Phy

For each of the above cases, the L2/L3 device is typically a PCI based device. However, software may or may not be able to identify whether or not the Layer 1 device is present in a system, and hence the need for the present invention arises. Thus, the present invention may also be utilized with any LAN or WAN complaint system.

Further embodiments may be readily apparent to one having the benefit of this disclosure. For example, the present invention has been described in the context of an

environment where there is a single L1 device coupled to a L2/L3 device, as shown in

FIG. 6A.

However, the present invention may be employed in environments where a plurality of L1 devices are coupled to a plurality L2/L3 devices, as shown in FIG. 6B. For

5 example, a router back card may be designed to have eight channels, but the customer only wishes to purchase a four channel system, or the vendor wishes to limit the number of channels available by loading components. Using the structure and methods of the

present invention, the back card may be configured to have the sensing lines of the active channels floating, and the sensing lines of the de-active channels brought to a low

10 potential. When the back card is coupled to a front card enabled with the present invention, the front card will automatically sense which channels are active and which channel are de-active, and communicate this information to the FE MAC on the front card, and the front card will couple the back card to the bus appropriately. In an exemplary non-limiting embodiment of the present invention, Phy to Mac device

15 mapping is 1 to 1.

Though the above description has been illustrated in the environment of a router, it is contemplated that the present invention may be employed where ever it is desired to determine whether there is a L1 device present in a PCI-compliant system. Appropriate modifications may be made to the structure and methods disclosed herein to adapt the



present invention to the desired environment without departing from the spirit if the  
present invention.

While embodiments and applications of this invention have been shown and  
described, it would be apparent to those skilled in the art that many more modifications  
5 than mentioned above are possible without departing from the inventive concepts herein.  
The invention, therefore, is not to be restricted except in the spirit of the appended claims.

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